

ASEPTIC SURGICAL TECHNIQUE.¹

WHAT ARE THE MINIMUM REQUIREMENTS FOR ASEPTIC SURGICAL OPERATIONS
IN HOSPITALS WHERE THE SURGEON IS ASSISTED BY A LARGE STAFF OF
INTERNS AND BY NURSES FROM A TRAINING-SCHOOL?

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WHEN we realize to what extent a large general hospital is a sort of dumping-ground, as it were, for all kinds of septic material, and that in many of these institutions there is, every few months, some change in the personnel of assistants or nurses, and especially if the situation is still further complicated by a large staff of surgeons, whose services are interrupted, it must at once be evident, from the point of view of asepsis, under what disadvantages the surgeons of these hospitals do their work. Because of these manifest disadvantages, the task of attempting to simplify the various aseptic processes in use in such hospitals is a delicate one. And yet the number of aseptic precautions has now increased to such a degree as to make it desirable, for the sake of simplicity, and in spite of the good results usually obtained under the old methods, to determine, so far as is possible, which are the really essential parts of the process and which can be done away with. It is obviously impossible, in such a subject as asepsis, to state dogmatically the exact degree to which the various details may be cut down without danger. I shall, therefore, content myself with making a few general observations on the subject, endeavoring at the same time to make no positive statements unless I feel that the known facts justify them. In doing this, I shall pass over certain details, as being too trite for discussion, and limit myself principally

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to points which to some may appear not so obvious, or about which there may be difference of opinion. Most of the methods here advocated have been put into practice at the Boston City Hospital. It is not claimed that all these methods are better than any others, but simply that they represent one of the ways, consistent with simplicity, in which satisfactory results may be secured.

(A.) PREPARATION FOR AN ASEPTIC OPERATION.

Sterilization of Materials in the Steam Autoclave.—It is found that exposure of materials* in the autoclave to a pressure of fifteen pounds of saturated steam for one half-hour is all that is necessary, provided that the bundles are loosely done up and loosely packed, so that all parts of them are readily accessible to the steam. This is, of course, a great saving in time over former methods, at least, as I have seen them practised. The half-hour should start from the time the air has been completely driven out, and the pressure-gauge registers fifteen pounds. The suggestion for diminishing the amount of time in using the autoclave was made to me by Dr. Charles Harrington, of Boston. That one half-hour is quite sufficient in practice has been proved by the Pathological Department of the Hospital; in fact, bundles containing cultures of the hay bacillus, in its sporing stage, have been found sterile even after fifteen minutes in the autoclave at fifteen pounds' pressure. Salt solution is sterilized in flasks by exposure for one half-hour at ten pounds' pressure.

Preparation of Absorbable Ligatures.—At the Boston City Hospital, at the present time, sterile catgut and kangaroo tendon are furnished to the hospital by reliable dealers. It is thought that, as practically the entire business reputation of such dealers rests upon the sterility of their catgut, it is more likely to be sterile than when prepared in the hospital. Where

* Gauze dressings, sponges, strips, pads, gowns, caps, sheets and towels, silk sutures and ligatures, silkworm gut, silver wire, etc. In case there is not sufficient room in the autoclave for all these materials, the gauze dressings may be equally well sterilized by baking in an oven.

the hospital facilities justify it, however, undoubtedly the best method is to have it prepared in the institution itself, under the eye of the surgeon. This method has, of course, the additional advantage of being by far the most economical.

Operating Room.—Whatever may be the actual danger of air infection, direct or indirect, and pending the results of more definite experiments, the demonstrated existence of pathogenic bacteria in the air of large hospitals * is presumptive evidence of the necessity of *some efforts* looking towards their exclusion. Because of the general truth that the more dust in the air the more bacteria, our efforts should, naturally, be in the direction of diminishing the amount of dust which is in the room, and of keeping such as remains quiet, thus leaving the air as free from it as possible. Therefore, as belonging to "minimum requirements," it is necessary to mop the floor, wipe the walls, fixtures, and furniture with damp cloths, and to minimize draughts from all sources. It is presumably safer also to filter the air. That the room should be such as to be easily cleaned is self-evident. Chan-

* In order to determine whether the air in the surgical amphitheatre of the Boston City Hospital contained essentially the same number and variety of bacteria found in other hospitals, the Pathological Department, at my request, made exposures of Petri plates for different periods of time during the twenty-four hours. Their conclusions were:

"1. That at no time in the twenty-four hours is the air free from organisms.

"2. That more bacteria were found after the air had been stirred up, as after the morning cleaning and the class exercises. The smallest number were found between the hours of midnight and 7 A.M.

"3. The vast majority of the organisms found were harmless saprophytes, though in some plates of every series *staphylococcus albus* and *aureus* were found. The *streptococcus* was found in two instances only.

"4. There was no great difference in the number of colonies obtained at different levels, excepting on those plates laid upon the floor, where the number of colonies was much in excess over the other plates. This was due to the people who passed through the amphitheatre at all hours."

These results are essentially the same as those of other investigators, all of them going to show that while air infection may not seem to be enough of a danger to require more than ordinary precautions, yet the possibility of infection in this way should not be disregarded, especially in a large hospital.

deliers above the operating table, on account of their catching the dust, and because of the difficulty in cleaning them, should be as simple as possible.

It will be extremely interesting to note whether sweeping by the vacuum system, now so extensively used in office buildings, may not be of value in thoroughly removing the dust from operating rooms. By this method the loose dust is sucked up from the different parts of the room, through a nozzle at the end of a hose, and is carried to the basement. I am not aware, however, that as yet the system has been installed in any hospital.

The proper disposal of septic material is *essential*. The usual method of throwing it into a hopper is probably safe, though a description of the trap-door method, which I understand is now in use in Hamburg, sounds more attractive.

Thorough and systematic fumigation of the operating room with formalin gas is, in my judgment, essential; at least, after all septic cases.

It is possibly safer to have one room for septic cases, and another for clean ones; although it is not at all certain that, with careful cleansing and proper fumigation, one room is not sufficient to meet the "minimum requirements." The advantage of the common practice of allowing the operations on clean cases to precede those on septic ones is so obvious as to hardly need mention.

An operating room, then, which can be easily cleaned, and *which is cleaned*, where the air is kept comparatively free from dust, where draughts are minimized, and where formalin fumigation is regularly and thoroughly practised, must, for the present at least, be regarded as all that is necessary to meet the "minimum requirements." All elaborate or ornate fittings or furnishings, giving the *appearance* of cleanliness, are luxuries of questionable value, if indeed they are not positive dangers, as they tend to give a false sense of security.

Preparation of the Patient's Skin.—Experience seems to have demonstrated that in the preparation of the patient's skin no special aseptic precautions are necessary on the day be-

fore operation. The patient should be given a hot bath, and the operating area should be thoroughly cleansed with soap and water and then shaved. That further preparation of the skin is presumably unnecessary is shown by the fact—probably corroborated by the experience of most surgeons—that accident and other emergency cases, on which only a final preparation is made, seem to do just as well, aseptically speaking, as those cases prepared with great pains in the hospital the day before. This suggestion—as to the source of which I am ignorant—has greatly simplified the aseptic process.

Chemical depilatories have been recommended by some as being quite as efficient as the razor for removing hair, and as having also an antiseptic effect of their own. I have had no actual experience with these agents, except to witness their extraordinary action in removing the hair from the arm and leg. Because of the fact that chemical depilatories, even if they should prove to be unirritating to the skin, are unstable compounds and are practically useless if not fresh, their use in general surgery would appear to have no special advantage over the razor.

Though a perfect sterilization of the skin of the patient—and this applies equally to the hands of the operator and his assistants—is probably impossible under any method, the use of 70 per cent. alcohol* has given very satisfactory results

*This was recommended to me by Dr. Harrington, who proved its value by bacteriological experiments. He declared that, while absolute alcohol has no effect whatever on dried bacteria, alcohol of 70 per cent. is a very satisfactory germicide. It is not claimed that this method is better than any other, but only that it yields equally good results, while it is simple, comparatively unirritating to most skins, and, for hospitals at least, inexpensive. The admixtures required by the United States Government do not detract from its efficiency.

Some time ago Dr. Harrington furnished me with a new mixture—"No. 9," he calls it—which, judging from the bacteriological tests made at the hospital, is strikingly effective in disinfecting the hands. As yet I have had no satisfactory opportunity of testing it clinically, but I am convinced from these experiments that, should it not prove too irritating, it will be of great value, especially in disinfecting the skin of the patient, and may displace even alcohol.

as a routine procedure for the last few months at the Boston City Hospital. After a thorough mechanical cleansing of the operating area, the alcohol (70 per cent.) is allowed to drip upon it for two minutes, the part being gently scrubbed at the same time with a sterile wad of gauze in the sterile hands of an assistant.

*Disinfection of the Hands.**—The use of 70 per cent. alcohol has been found equally satisfactory for disinfecting the hands; this, of course, after a very thorough mechanical cleansing. The details are as follows:

1. The hands are very thoroughly washed in hot water, a bristle brush being used. No time is specified for this process, it being required only that the hands should be thoroughly clean in the ordinary sense, and the skin soft. Obviously, such a process should take longer with some hands than with others.†

2. The hands are thoroughly dried with an ordinary clean towel. During this process a good deal of softened epidermis may be rubbed off. The nails, being now comparatively soft and pliable, may be trimmed with the scissors; and the closer they are trimmed the better. The spaces beneath the extremities of the nails are cleansed by the nail-cleaner, the projecting flesh at the base of the nails is pushed back, and all hang-nails cut off.

3. The hands are washed a second time with soap and hot water.

4. They are washed off with sterile salt solution.

5. They are soaked in 70 per cent. alcohol *for two minutes*. This is the only part of the process where time is specified.

* It is hardly necessary to call attention to the well-known necessity of avoiding contamination of the hands at any time with septic material. Sterile instruments should be used in changing septic dressings, or rubber gloves should be worn.

† The suggestion of Freeman, that the hands should be given a chance to perspire by wearing gloves for a long time before sterilization, or by immersing the gloved hands in hot water, seems an excellent one, but it adds very much to the detail of preparation.

6. The hands are dried on a sterile towel, and they are ready for the gloves.

*Gloves.**—I am aware that some successful surgeons do not use gloves; nevertheless, I am unable to accept this as evidence of absence of danger from the ungloved hand, for what may not be a danger with one man may be so with another. Rubber gloves should be thoroughly washed after operation, and boiled for six minutes. They should then be inspected for punctures. If it is possible to repair them, they should be mended, and then tested again. They should then be powdered, wrapped in cloths, and sterilized in the autoclave for one half-hour at ten pounds' pressure.† Gloves may also be sterilized by simple boiling.

Instruments.—The customary ten minutes' boiling of instruments has been proved to be sufficient, if properly carried out. One source of infection is the neglect of a precaution, well-recognized, but, to my knowledge, not always carried out. It is absolutely essential that instruments which are difficult to clean, and which remain for a long time in close contact with the tissues in a wound, should be taken apart before sterilizing. Hæmostatic forceps, for instance, with their corrugated jaws, are particularly dangerous if not unlocked before being boiled. Cultures taken from the jaws of forceps which had been soiled with pus, the jaws tightly locked, and the instruments boiled for ten minutes, still yielded positive results. When one considers how hæmostatic forceps crush the tissues, and how long they stay in contact with them, it is difficult to imagine a better method of infection in case the jaws are not sterile. No excuse should justify failure on the part of the assistant to satisfy himself that the forceps have been properly sterilized.

* The only method of procedure, which, if ultimately it prove practicable, is likely to replace the use of gloves, with the attendant danger of infection from puncture, is covering the hands with an impermeable coating.

† Wandel and Höhne seem to have succeeded in sterilizing them by mechanical cleansing alone; but I do not know that their methods have been put into general practice by others.

Caps and Masks.—The theoretical danger of infection from the head and mouth of the surgeon justify our insisting upon the wearing of caps and masks at aseptic operations—at least, at major operations—until their necessity is disproved. If caps are not worn, the surgeon's hair often comes in contact with that of his assistant, directly over the wound, and particles of dust, dandruff, and bacteria are likely to descend into it. I have good authority for the statement that saliva contains more bacteria, volume for volume, than sewage.* Minute particles of highly infectious material may be expelled from the mouth, and possibly from the nose, during talking, coughing, or sneezing.

The gauze mufflers which are generally used for masks are most uncomfortable to wear during an operation, and, if the surgeon wears glasses, these are apt to be obscured from time to time by his breath which escapes from the muffler just below them. I have found the Vienna masks, made on a wire frame, much more comfortable than the ordinary mufflers.

Solutions.—The tendency nowadays is to dispense with all solutions during an operation, except warm sterilized salt solution for irrigating and washing. Dipping instruments into corrosive solutions, or rinsing the hands for a few seconds, as we see so frequently done, has no antiseptic effect whatever.

(B.) CONDUCT OF AN ASEPTIC OPERATION.

In the conduct of an aseptic operation, the following are essential on the part of all engaged:

* "In addition to the care of the hands, the surgeon should also have washed his face thoroughly; and if he wears a beard or moustache, special heed must be paid to the cleanliness of these. Very little attention is usually paid to the cleansing of the mouth; yet, when it is remembered that the saliva contains a larger number of micro-organisms than the worst sewage, that streptococci and staphylococci are amongst the most numerous of these, and that they are proved to pass into the air in loud talking or coughing, it would appear worth the surgeon's while to take into account a cavity which comes so near the operation wound." *Lessons in Disinfection and Sterilization*. F. W. Andrews, Lecturer on Pathology, Pathologist and Sanitary Officer to St. Bartholomew's Hospital, London, 1903, p. 123.

1. Belief in the aseptic idea.
2. Fixed habits of asepsis.
3. Co-operation, or "aseptic team-work."

Assistants should be taught, what the surgeon already knows, that the fewer the hands entering into an operation, the less the wound is touched with the fingers, the less the talking over it, the shorter the time consumed in operating, the less the ligatures are exposed or handled, just so much less is the danger of infection.

The care of the ligatures, as we all know, is one of the most important details of the operation. Unlike instruments, and, therefore, more dangerous, they are put into the wound to stay there; and if bacteria go with them, such bacteria are not so likely to be removed later, during sponging or irrigating, as those introduced in other ways. It is rather unfortunate that the usual way of putting up catgut is to roll it upon a glass reel, for the temptation to straighten it out in the fingers is almost irresistible; in fact, this, to some extent, is necessary, but the process may easily infect it, especially if it has to pass from hand to hand.

Considering the fact that probably few wounds are absolutely germ-free, and also that latent germs in the tissues may be awakened by injury, *assistants should also be taught* the importance of injuring tissues as little as possible by manipulation or too much irrigation; of the necessity of removing blood and stopping hæmorrhage; of leaving a dry wound; of uniting the deeper parts of it by buried stitches, enough room being allowed between them for drainage; and of remembering to apply this same rule to skin sutures, special drainage being used for large wounds, particularly where "dead spaces" exist.

In addition to learning the necessary measures to be taken before and after the operation to diminish the chances of auto-intoxication, *assistants should also know* the importance of strengthening the resisting power of the patient's tissues in every possible way; for the general physical condition of the patient, and possibly the psychical, may often,

so far as asepsis goes, be the determining factors in the case.

All these, and many similar points, should be inherited, as it were, by one assistant from another, and become incorporated into that common knowledge which, especially in a hospital where change is the order of the day, is of more value in keeping up the standard than all else, namely, "hospital tradition."

Many of these precepts *the nurses* should be equally familiar with, and it belongs to those in charge of the training-school to *instruct them* in the theory of asepsis; and to the surgeon or his assistants, but especially to the head nurse in charge of the operating floor,—a person who is usually selected for her general efficiency in surgical work,—to see that they are made familiar with the proper practice of it.

SUMMARY OF MINIMUM REQUIREMENTS FOR ASEPTIC WORK, AS GIVEN IN THIS PAPER.

1. Materials to be sterilized in saturated steam in the autoclave, for one half-hour, under fifteen pounds' pressure; rubber gloves and salt solution under ten pounds' pressure. If there is not sufficient space in the autoclave for the gauze dressings they may be baked.

2. In hospitals without proper facilities for sterilization of absorbable ligatures, these to be obtained from reliable dealers whose business reputation is at stake.

3. An operating room which can be easily cleaned, and *which is cleaned*, where the air is kept as free from dust as possible, where draughts are minimized, and where formalin fumigation is thoroughly and systematically practised.

4. A hot bath for the patient, and a cleansing and shaving of operating area the night before operation if possible (as an extra precaution). Just before operation, a second cleansing, and sterilization with 70 per cent. alcohol or some equally efficient method.

5. Thorough mechanical cleansing of the hands, and sterilization by 70 per cent. alcohol or some method equally efficient.

6. Ten minutes' boiling for instruments, special attention being paid to taking apart clamps and hæmostatic forceps, or at least unlocking them.

7. Caps, masks, and sterile gloves always to be worn, at least on major cases.

8. Warm sterile salt solution for irrigation and washing.

9. Belief in the aseptic idea, fixed aseptic habits, and aseptic co-operation, on the part of all engaged in an operation.

10. Instruction of assistants and nurses as above set forth.